



Estimating & Valuing Human Health Effects of State and Local Emissions Reductions

The Co-Benefits Risk Assessment (COBRA) Beta Model

A Presentation for the Renewable Energy
Modeling Series
November 7, 2003

COBRA Background

- **EPA's State and Local Capacity Building Branch supports state and local voluntary efforts to:**
 - ◆ improve air quality and public health,
 - ◆ increase energy efficiency (EE) and renewable energy,
 - ◆ promote economic development, and
 - ◆ lower GHGs.
- **With tools and analyses, we build S&L capacity to make informed decisions, maximize benefits**
 - ◆ Tremendous analytic gaps exist, particularly on the benefit-side of the equation.
 - ◆ Resource (\$) gaps exist, too.

More COBRA Background

- Wisconsin wanted help: WI Climate Change Action Plan called for significant amounts of fuel switching (coal to NG) and EE improvements in the electric utility sector.
 - ◆ Actions would reduce GHGs but, if implemented, they would also reduce air pollution which would yield human health benefits.
 - ◆ WI estimated the costs/savings, emission changes associated with the fuel switching and efficiency investments
 - ✦ Did not calculate the air quality (AQ) or human health impacts
- Under EPA Contract, Abt Associates, Inc analyzed AQ and human health effects, valued them for WI.
 - ◆ Analysis **evolved into** desire to give other states the ability to do their own “quick and dirty” assessment of health effects from air pollution reductions via a tool we’re now developing named **COBRA**.

What is COBRA?

- The Co-Benefits Risk Assessment (COBRA) model is a draft screening tool that inexpensively and quickly estimates the air quality, human health, and associated economic impacts of various state-level emission reduction scenarios.
 - ✦ Model visually maps health effects by county for state, region, U.S.
- Beta models now exist for 10 states

How Does COBRA Work?

- User enters change in air emissions (e.g. Sulfur dioxide, nitrogen oxides, volatile organic compounds, particles, ammonia)
 - ◆ COBRA contains county-level 2007 business-as-usual (BAU) air emissions estimates

- COBRA
 - ◆ **quantifies the associated change in particles**
 - ✦ Using a simple air quality model used by EPA in previous analyses
 - ◆ **calculates the change in health effects**
 - ✦ Using concentration response (C-R) functions that link the change in particles with epidemiological studies
 - ◆ **estimates monetary value of health effects avoided**
 - ✦ based on direct medical costs, Value of statistical life, Willingness-to-pay, Cost-of-illness values
 - ◆ **visually maps benefits by county for state, region, U.S.**

Human Health Effects in COBRA

- Incidences avoided & their economic value:
 - ◆ Mortality, Chronic Bronchitis, Non-fatal Heart attacks, Respiratory Hospital Admissions, Cardiovascular-related Hospital Admissions, Acute Bronchitis, Upper Respiratory Symptoms, Lower Respiratory Symptoms, Asthma ER visits, Minor Restricted Activity Days, Work Loss Days
- Incidences avoided:
 - ◆ Asthma Effects - attacks, shortness of breath, & wheezing

Economic Values of Effects

Health Incident Avoided	Economic Value (\$2000)	Source of Value
Premature Death	\$6.0 million	VSL
Non-Fatal heart Attacks	\$66,000 – 141,000	Costs of Illness (COI) = Direct medical costs, opportunity cost (OC)
Chronic bronchitis	\$340,000	WTP
Hospital Admissions	\$7,500 – 23,000	COI = Hospital charges, OC
ER visits	\$286	COI = Costs to the hospital
Work loss days	Varies	WTP = County-specific median daily wage

Strengths of COBRA

- Enriches discussion of co-benefits for states
- **Easy-to-Use** screening tool
 - ◆ Requires minimal inputs
 - ◆ Includes “canned” equations and approaches used by EPA in previous analyses
 - ◆ Detailed User’s Guide describes all assumptions and equations
- **Flexible** for User
 - ◆ Can enter data for a single county, group of counties, or statewide
 - ◆ Can enter reductions in absolute terms or as percentage change
- **Inexpensive (free!)** compared to rigorous air quality models
 - ◆ Results from COBRA approach have fared well in informal comparisons
- **Quick** to generate results
- Mapping of results facilitates **visualization** of impacts
 - ◆ Provides very localized health effects and valuations: county level

Weaknesses and Limitations


- Model is **beta** tool, available for only 10 states
- Somewhat **inflexible**, too **simple**
 - ◆ Limited Year for analysis (currently 2007 only)
 - ◆ Inability to import own baseline
 - ◆ Must use “canned” equations (C-R functions, economic values)
 - ◆ Enables pollution changes for own state only
- Air Quality (AQ) model is “**quick and dirty**”; pending revision
 - ◆ COBRA is best used as screening tool, followed up with comprehensive AQ analysis and health impact assessment
 - ◆ EPA OAQPS developing new AQ modeling approach that may be incorporated
- Relies upon **inputs generated elsewhere**
 - ◆ States may not have access to models to generate pollution estimates
 - ◆ Assumptions about statewide % reductions = oversimplification
 - ◆ To improve analysis, baseline should be calibrated with state & model expectations

Sample Scenario - NY Switch to Wind

- Suppose New York announces a shift to wind power that will reduce emissions in the electric utility sector by 10% in 2007.
- User needs to calculate emission changes (inputs):
 - ◆ Use **other analysis or model** - estimate reductions in pollutants from 10% reduction in state's FF-based electricity generation
 - ✦ Using NY Energy Plan 2002, electricity demand for 2007 = @169,020 GWhs;
 - @48% from FF combustion = 81,299 GWhs *10% = 8,129 GWhs reduced
 - Plan projects 2007 SO₂ = @160K tons*10% = 16K; 2007 NO_x emissions = @ 70K tons *10% = 7K
 - ✦ User could look to energy models = possible sources for inputs
 - e.g. Integrated Planning Model, Energy 2020, others?
 - ◆ OR enter **statewide reduction as percentage** (10%) into COBRA

Input-related Challenges

- COBRA does not tell you the correct amount of wind or other renewable energy source necessary to achieve 10% reductions.
- Specifics about geographic location of reductions and fuels displaced would enhance analysis
 - ◆ Assumptions of 10% reduction across state will yield different results than targeted reductions in particular counties
 - ◆ What fuel will be displaced? At what plant? In what county is the plant?



COBRA

New York State

Beta Version 1.1

Scenario Options

Run a new scenario:
☒ statewide
☐ for individual counties:

☐ Albany
☐ Allegany
☐ Bronx
☐ Broome
☐ Cattaraugus
☐ Cayuga
☐ Chautauqua
☐ Chemung
☐ Chenango

Start

OverviewEmissions

Welcome to the New York State Co-Benefits Risk Assessment Model (COBRA)

To begin using COBRA, you may:


1) Explore the baseline emissions data.

This data can be accessed in table and map form by clicking on the "Emissions" button above. Viewing the baseline data first can help you decide what changes you want to make in your own scenario.

2) Create your own scenario.

You can create a new scenario through the options on the left panel of this page.

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COBRA

New York State

Beta Version 1.1

**Base Emissions
Table Options**

Current table:

Data for: New York State

Divided by: County

View new table by:

---choose view---

---choose view---

State total - by county

State total - by category

Albany

Allegany

Bronx

Broome

Cattaraugus

Overview

Emissions

Base Emissions: Tables

Base Emissions: Maps

Export All Emissions Data

Summary of data for: New York State

COUNTY	PM25	SO2	NOX	NH3	VOC
Chemung	736.4414	1035.6597	3162.6077	669.4696	3890.416
Chenango	809.4142	1020.4895	2250.9108	1175.3571	2107.0136
Clinton	1231.1936	1897.7732	4135.8875	1098.6098	3264.7494
Columbia	667.9596	487.8	2472.8282	843.6555	2269.2406
Cortland	575.6597	612.0054	1513.0054	862.1646	2141.1618
Delaware	764.2789	636.0152	1894.3504	967.7943	2412.2105
Dutchess	2170.8679	5169.4303	10093.7236	823.9921	10886.9461
Erie	10704.597	115777.7648	37632.9115	2803.4895	37334.8599
Essex	1161.54	1819.1249	1753.4528	263.4516	1943.8354
Franklin	579.61	253.5056	1895.3182	926.4578	1683.8989
Fulton	498.985	602.3674	1538.0044	467.0509	2295.1905
Genesee	598.389	636.1362	2319.7124	1545.2116	2287.1072
Greene	482.7614	205.0905	4962.8778	242.9445	1785.2716
Hamilton	140.6688	47.9868	226.441	35.3837	486.4457
Herkimer	1253.7915	941.9961	2484.9012	1030.777	2863.6397

Note: All values are in tons of emissions. Data represent estimates for 2007.

Co-Benefits Risk Assessment Model (COBRA)

File View Help



COBRA

New York State

Beta Version 1.1

Base Emissions

Map Options

Current map view:

Pollutant:

SO₂

Category:

All categories (total)

Change map quantity:

--pollutant--
--pollutant--
NH₃
NO_x
PM 2.5
SO₂
VOC

Change numeric breaks:

Change

Overview

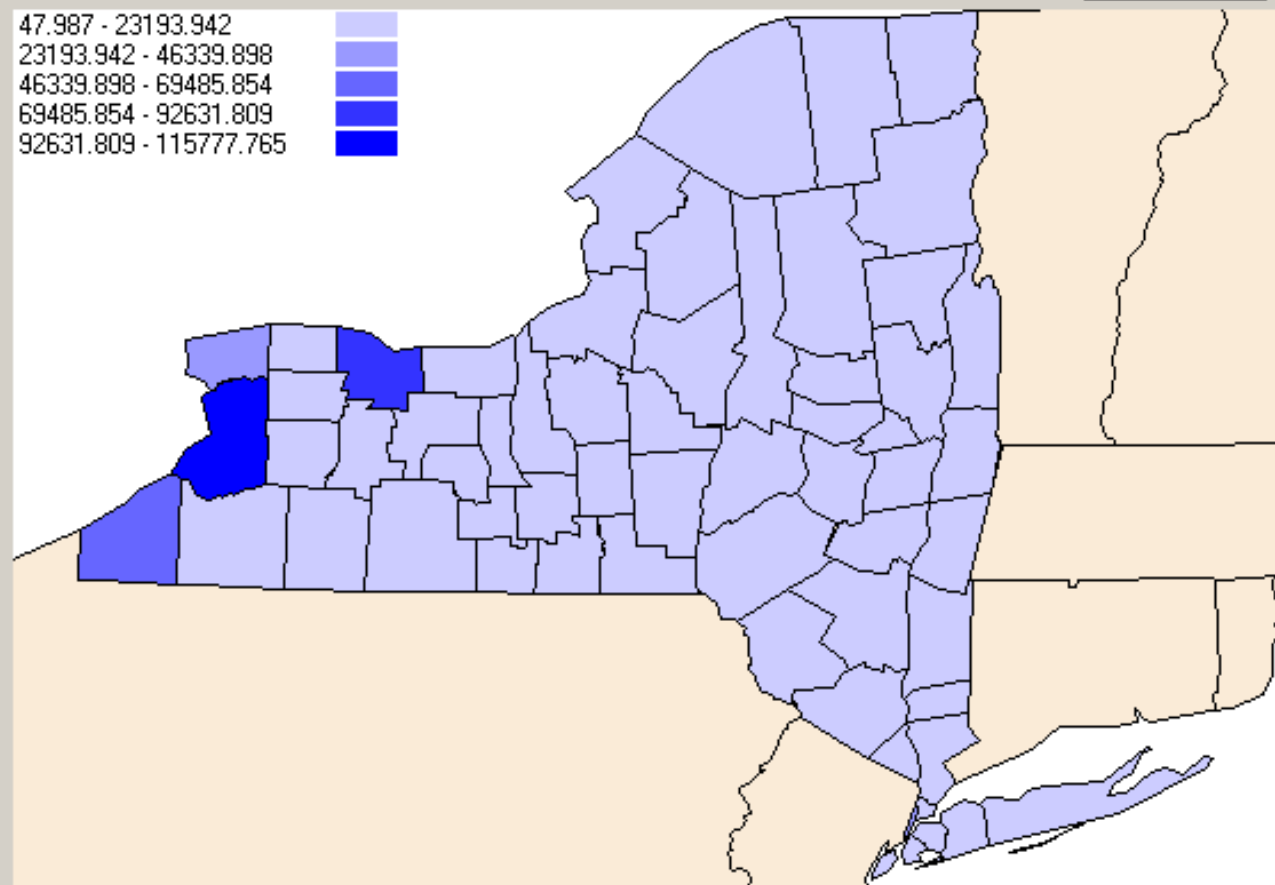
Emissions

Base Emissions: Tables

Base Emissions: Maps

Export Map

47.987 - 23193.942
23193.942 - 46339.898
46339.898 - 69485.854
69485.854 - 92631.809
92631.809 - 115777.765



* Assume
a 10%
reduction
across all
pollutants
or enter
absolute
reductions
estimated
elsewhere

Define scenario

New York State

Currently active category:
Fuel Comb. Elec. Utility

- Chemical & Allied Product Mfg
- Fuel Comb. Elec. Utility**
 - Coal
 - Gas
 - Internal Combustion
- Fuel Comb. Industrial
- Fuel Comb. Other
- Highway Vehicles
- Metals Processing
- Miscellaneous
- Natural Sources
- Off-Highway
- Other Industrial Processes
- Petroleum & Related Industries
- Solvent Utilization
- Storage & Transport
- Waste Disposal & Recycling

Edit this category's emissions:

PM 2.5: ☒ reduce by 10 ☒ percent ☐ tons

SO₂: ☒ reduce by 10 ☒ percent ☐ tons

NO_x: ☒ reduce by 10 ☒ percent ☐ tons

NH₃: ☒ reduce by 10 ☒ percent ☐ tons

VOC: ☒ reduce by 10 ☒ percent ☐ tons

Apply Edits

<-- Back Summarize Edits Run Scenario -->

Co-Benefits Risk Assessment Model (COBRA)

File View Help



COBRA

New York State

Beta Version 1.1

Air Quality Table Options

Current table:

Scenario Name:

Switch 10% to Wind

View:

New York

View new table by:

---choose state---

---choose state---

All States

Alabama

Arizona

Arkansas

California

Colorado

Connecticut

Overview

Emissions

Scenario 1

Scenario Emissions: Tables

Air Quality: Tables

Health Effects: Tables

Results: Maps

Export Table

County	State	CtrlPM25	BasePM25	DeltaPM25
Albany	NY	23.102	23.133	.03
Allegany	NY	13.986	14.026	.04
Bronx	NY	49.916	49.937	.021
Broome	NY	14.99	15.027	.038
Cattaraugus	NY	14.334	14.365	.031
Cayuga	NY	14.72	14.749	.029
Chautauqua	NY	13.291	13.353	.063
Chemung	NY	13.979	14	.021
Chenango	NY	14.784	14.809	.024
Clinton	NY	16.526	16.552	.026
Columbia	NY	15.858	15.887	.029
Cortland	NY	14.594	14.62	.026
Delaware	NY	14.081	14.108	.028
Dutchess	NY	16.913	16.942	.029
Erie	NY	22.653	22.738	.085

Note: All values are in ug/m3. Data represent estimates for 2007.

Co-Benefits Risk Assessment Model (COBRA)

File View Help



COBRA

New York State

Beta Version 1.1

Health Effects Table Options

Current table:

Scenario Name:

Switch 10% to Wind

View:

New York

View new table by:

---choose state---

---choose state---

All States

Alabama

Arizona

Arkansas

California

Colorado

Connecticut

Overview

Emissions

Scenario 1

Scenario Emissions: Tables

Air Quality: Tables

Health Effects: Tables

Results: Maps

Export Table

County	State	Mortality ▾	Mortality \$	Chronic Bronchitis	Chronic Bronchitis \$
Erie	NY	4.47	26,848,980	2.61	888,648
Queens	NY	2.17	13,023,950	1.87	635,602
Monroe	NY	1.97	11,858,814	1.4	475,198
Kings	NY	1.91	11,509,590	1.44	490,408
Nassau	NY	1.8	10,801,804	1.34	456,464
Suffolk	NY	1.44	8,656,727	1.12	381,294
New York	NY	1.17	7,026,383	1.06	361,305
Bronx	NY	1.06	6,398,652	.76	259,683
Onondaga	NY	.83	5,017,923	.57	195,716
Westchester	NY	.83	5,013,201	.67	229,522
Orange	NY	.77	4,624,149	.61	207,887
Chautauqua	NY	.46	2,739,269	.28	94,072
Albany	NY	.42	2,529,114	.28	96,829
		25.90	155,738,168	18.55	\$6,317,390

Note: All values represent the change in the number of annual cases and the valuation of the health effect. Data represent estimates for 2007.

Co-Benefits Risk Assessment Model (COBRA)

File View Help



COBRA

New York State

Beta Version 1.1

Results Map Options

Current map view:

Scenario Name:

10% FF Red

Quantity:

Mortality

Change map quantity:

---health effect or PM---

---health effect or PM---

Mortality

Chronic bronchitis

Non-fatal heart attacks

Hospital adm. - Resp.

Hospital adm. - CDV

Acute Bronchitis

Upper Resp. Symptoms

Change

Overview

Emissions

Scenario 1

Scenario Emissions: Tables

Air Quality: Tables

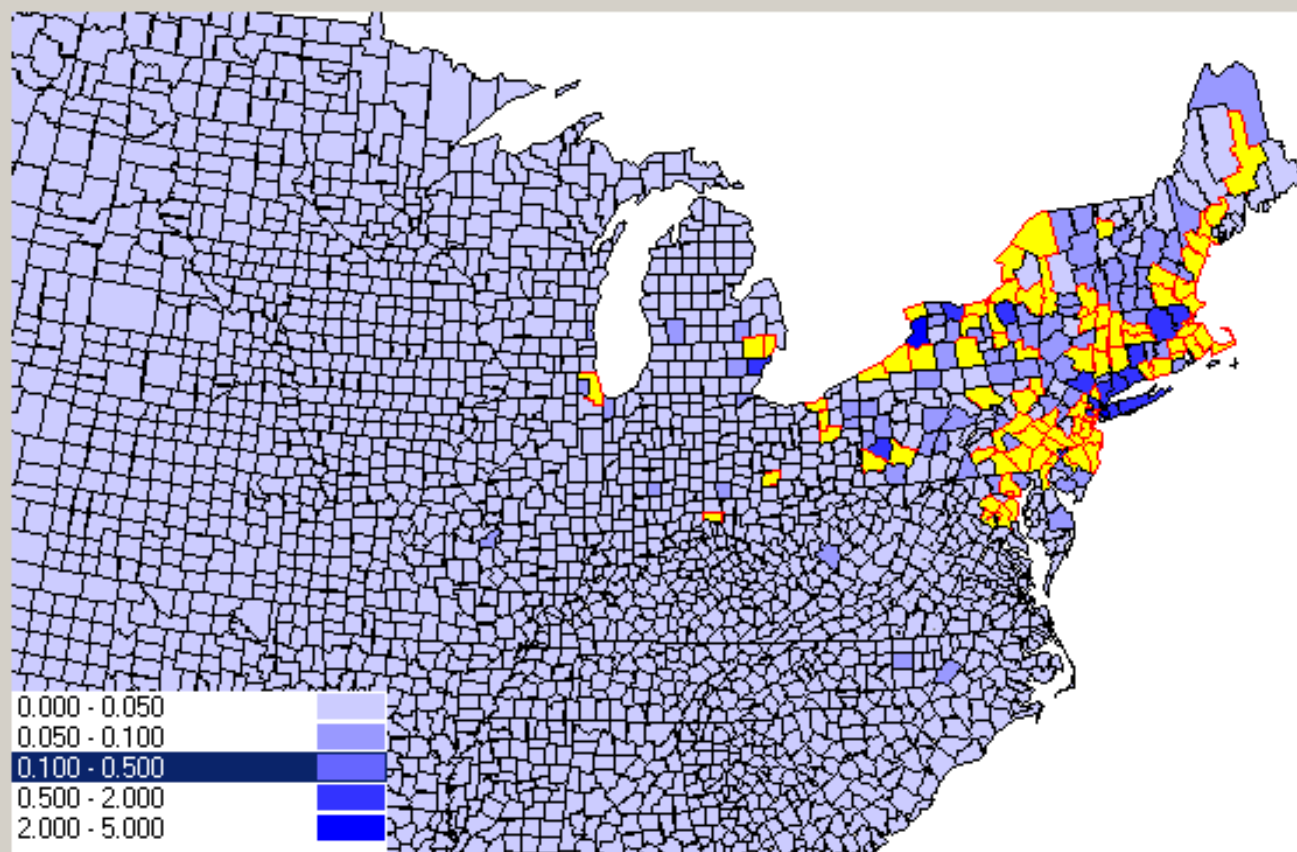
Health Effects: Tables

Results: Maps

Zoom tools:



Export Map





COBRA
New York State
Beta Version 1.1

Results Map Options

Current map view:

Scenario Name:
10% FF Red

Quantity:
Mortality

Change map quantity:

---health effect or PM---

---health effect or PM---

Mortality

Chronic bronchitis

Non-fatal heart attacks

Hospital adm. - Resp.

Hospital adm. - CDV

Acute Bronchitis

Upper Resp. Symptoms

Change

Overview

Emissions

Scenario 1

Scenario Emissions: Tables

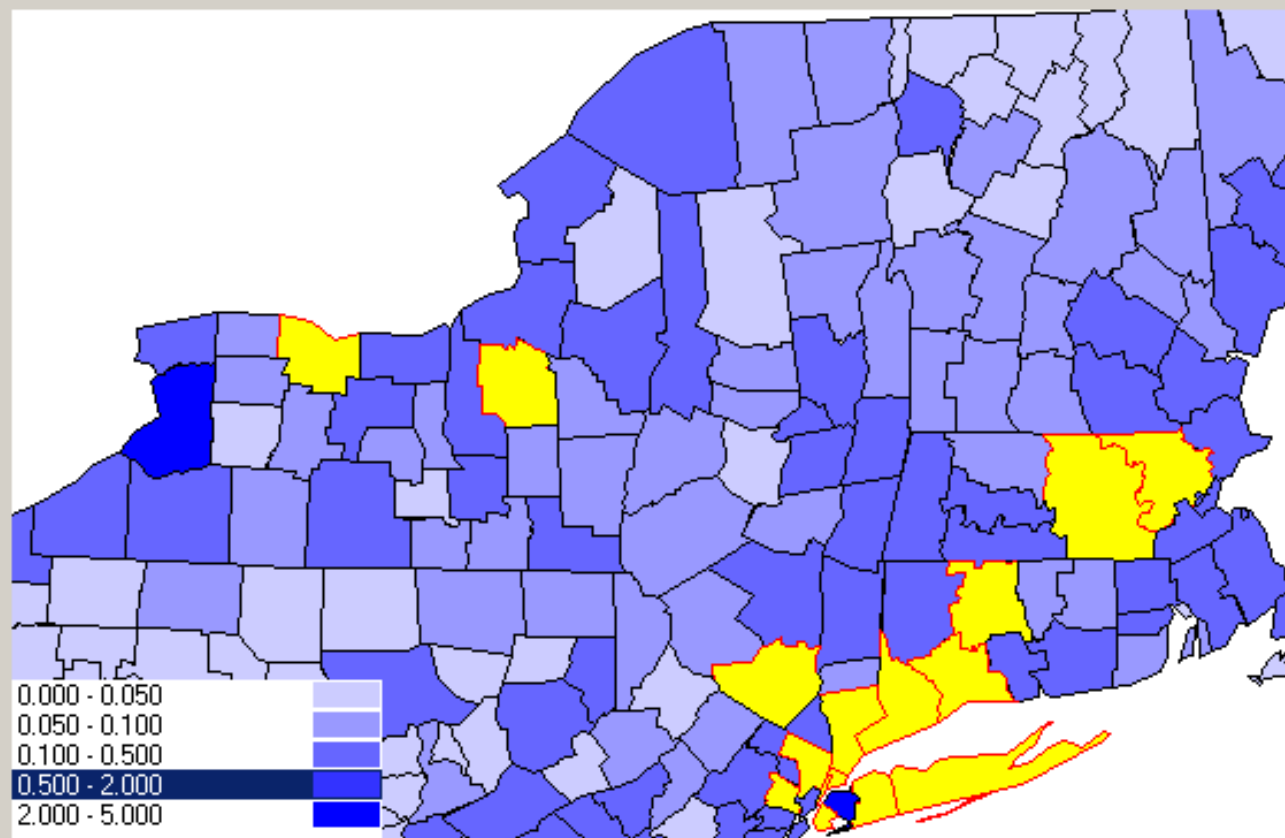
Air Quality: Tables

Health Effects: Tables

Results: Maps

Zoom tools:

Export Map





COBRA
New York State
 Beta Version 1.1

Results Map Options

Current map view:

Scenario Name:

10% Decrease FF
 Electric

Quantity:

Asthma ER Visits

Change map quantity:

- Asthma ER Visits
- Lower Resp. Symptoms
- Asthma ER Visits
- Work Loss Days
- MRAD
- Asthma Attacks
- Asthma - Shortness of Brea
- Asthma - Wheezing
- Delta PM 2.5

Change

Overview

Emissions

Scenario 1

Scenario Emissions: Tables

Air Quality: Tables

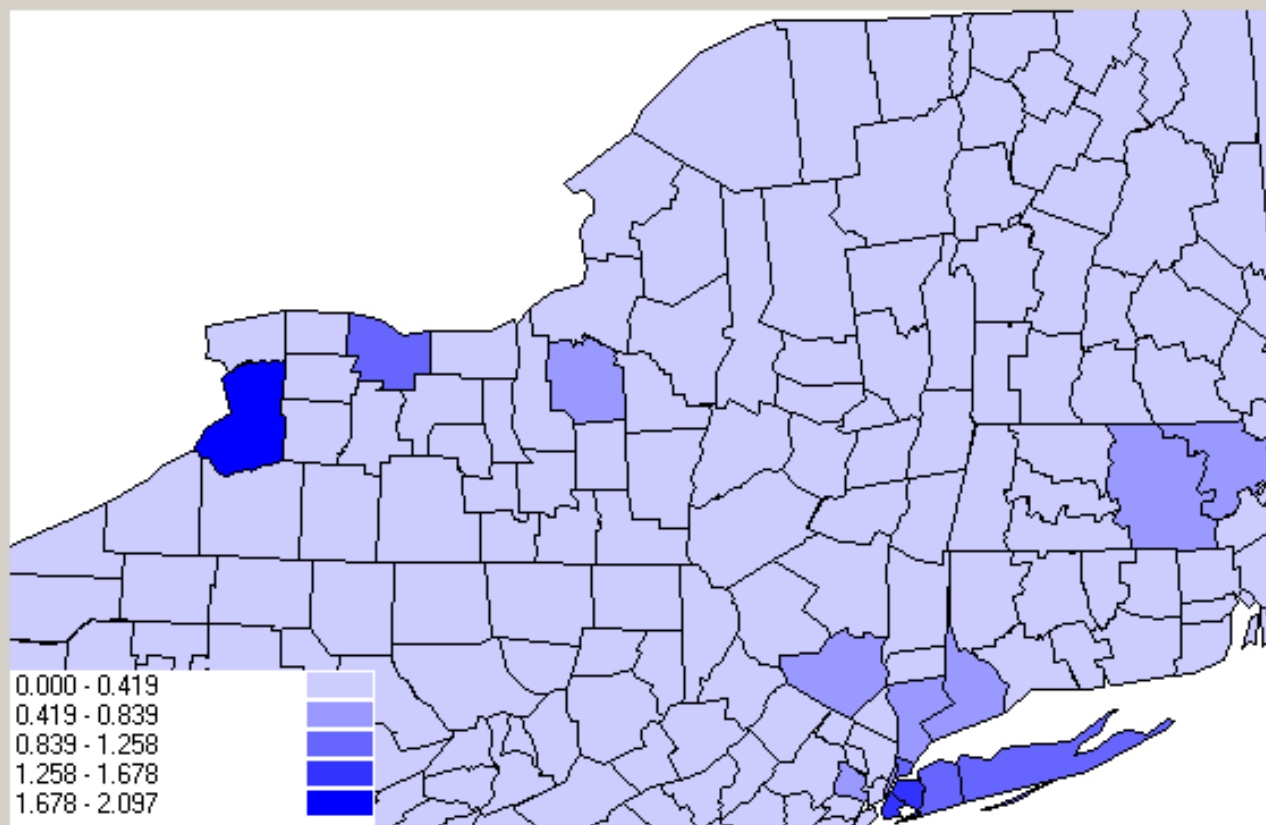
Health Effects: Tables

Results: Maps

Zoom tools:



Export Map



COBRA 2007 Health Results for NY & US: 5-10-15-20% Reductions in NY

% Reduction in NY FF Electric Emissions	Region	Mortality	Chronic Bronchitis	Nonfatal Heart Attacks	ER Visits	WLD	Asthma Attacks
5%	US	31	22	60	22	4247	716
10%		61	44	120	44	8490	1432
15%		92	66	180	66	12734	2147
20%		123	87	241	88	16976	2863
5%	NY	13	9	27	8	1802	305
10%		26	19	53	16	3601	610
15%		39	28	80	24	5400	915
20%		52	37	107	32	7198	1220

COBRA 2007 Results for NY & US : 5-10-15-20% Reductions in NY

NY FF Electricity Change	Benefits (2000 \$)	
	NY	US
-5%	\$266,764,788	\$6,647,359,035
-10%	\$533,039,058	\$13,287,709,964
-15%	\$799,250,433	\$19,926,290,570
-20%	\$1,065,374,949	\$26,562,659,693

2007	PM2.5	SO2	NOX	NH3	VOC	GWhs
NY Base*	3,458	188,380	66,297	123	624	81,299
Reductions						
-5%	173	9,419	3,315	6	31	4,065
-10%	346	18,838	6,630	12	62	8,130
-15%	519	28,257	9,944	19	94	12,195
-20%	692	37,676	13,259	25	125	16,260

* Base Case Sources: Tons of Emissions = COBRA; GWhs of fossil fuel generation based upon estimates in NY State Energy Plan 2002 (not COBRA)

Next Steps

- **Model refinement**
 - ◆ Air quality modeling approach
 - ◆ Design, features
- **Formal technical peer review - late 2004?**
- **Figure out ways users can improve input data**
 - ◆ identify for users tools, approaches to figure out where reductions might geographically show up (e.g. which power plant, county, etc)

For More Information

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